Synthesis of Monitoring at the Cornfield Shoals Disposal Site July 1991 to May 1992

Disposal Area Monitoring System DAMOS

D A M O S

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13. ABSTRACT

Preliminary evidence of active bed transport at the Cornfield Shoals Disposal Site (CSDS) prompted the National Marine Fisheries Service and Connecticut Department of Environmental Protection to express concern about possible sediment transport towards, and impact on, shellfish beds located north of the site, north of Long Sand Shoal. This preliminary study was designed to determine if the field-observed transport at the disposal site is consistent with the predicted east-west transport pattern found in the historical record.

This investigation at CSDS between July 1991 and May 1992 provided strong circumstantial evidence for active bed transport. This study included a series of bathymetric surveys, current meter suspended sediment data collection, and REMOTS photography of the sediment-water interface. The circumstantial evidence for active bed transport included shifts in areas of sediment accumulation and erosion, increased suspended sediment deposits at the sediment-water interface. In general, active bed transport appears to follow the historical east-west current direction, and the extent of the transport depends on the type of material. The actual direction and magnitude of active bed transport apparently depend on local topography and the nature of materials being transported.

Sediment accumulated over a broad area near the disposal points of sand hydraulically dredged from the Connecticut River in September 1991. Subsequent bathymetric surveys showed apparent movement of this material to the west. A clearly defined deposit formed at the disposal point for fine-grained material mechanically dredged from North Cove, Connecticut. This deposit of fine-grained dredged material apparently did not move, but was partially covered by bedload transport of adjacent coarse-grained sediments.

The present study concluded that:

The predominant transport direction at the site appears to be east-west. This is supported by current meter deployments and observed erosion and deposition patterns.

Sediment disposed at the side was not immediately dispersed and was defined within discrete deposits. This was observed for both fine-grained and sandy sediments.

The dispersion process appears to occur over a period of weeks to months. The dispersion rate for fine-grained materials may be markedly slowed by sand armor that migrates over the more cohesive, less erosive silt-clay.

The above findings, taken over the ten month time period, reduce concerns about far field transport of material over oyster beds to the north. The dispersion of material over a time scale of years, and the effectiveness of the sand armor over the silt-clays are unknown.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

EXECUTIVE SUMMARY

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This investigation at CSDS between July 1991 and May 1992 provided strong circumstantial evidence for active bed transport. The study included a series of bathymetric surveys, current meter and suspended sediment data collection, and REMOTS® photography of the sediment-water interface. The circumstantial evidence for active bed transport included shifts in areas of sediment accumulation and erosion, increased suspended sediment concentrations in the bottom waters coupled with high bottom currents, and bedforms and lag deposits at the sediment-water interface. In general, active bed transport appears to follow the historical east-west current direction, and the extent of transport depends on the type of material. The actual direction and magnitude of active bed transport apparently depend on local topography and the nature of materials being transported.

Sediment accumulated over a broad area near the disposal points of sand hydraulically dredged from the Connecticut River in September 1991. Subsequent bathymetric surveys showed an apparent movement of this material to the west. A clearly defined deposit formed at the disposal point for fine-grained material mechanically dredged from North Cove, Connecticut. This deposit of fine-grained dredged material apparently did not move, but was partially covered by bedload transport of adjacent coarse-grained sediments.

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The above findings, taken over the ten-month time period, reduce concerns about far-field transport of material over oyster beds to the north. The dispersion of material over a time scale of years, and the effectiveness of the sand armor over the silt-clays, are unknown.

1.0 INTRODUCTION

A series of investigations at the Cornfield Shoals Disposal Site (CSDS) between July 1991 and May 1992 provided circumstantial evidence for active bed transport. These studies included current meter data and survey data as part of a joint project between Dr. W. F. Bohlen and staff at the University of Connecticut (UCONN) and the Newport, RI office of Science Applications International Corporation (SAIC). Evidence for active bed transport includes optical backscatter and transmissometer data, bedforms, sand over mud, and shifts in sediment accumulation over time. In addition, current meter and survey results support the predominantly E-W current flow described in the historical records (NUSC 1979). Bathymetric and REMOTS® survey results show that dredged material can accumulate at the site despite active bed transport.

CSDS, located 3.3 nmi southeast of Cornfield Point in Old Saybrook, Connecticut, has been under study by the New England Division (NED) of the US Army Corps of Engineers since 1978 (Figure 1-1). It is the only dispersive dredged material disposal site managed by NED as part of the Disposal Area Monitoring System (DAMOS) Program. At a dispersive site, unlike a containment site, it is expected that the dredged material disposed at the site will be transported out of the area. CSDS received low volumes of sandy dredged material (29,000 m^3 annually) throughout the 1980s (SAIC 1991) although some fine-grained dredged material (4,200 m^3 from North Cove) was released at the site in January 1988. Before a disposal buoy was deployed at CSDS in 1991, barges released dredged material at designated LORAN coordinates, usually at the center of the disposal site.

Bathymetric surveys conducted in 1979, 1987, and 1990 did not detect a well-defined dredged material mound. A REMOTS® survey in 1990 detected fine-grained dredged material near the center of the site and showed evidence of active sediment transport in bedforms, sand over mud stratigraphy, and possible winnowing of the finer portion of the sediment (SAIC 1994). The National Marine Fisheries Service and the Connecticut Department of Environmental Protection have expressed concern about possible sediment transport towards, and impact on, shellfish beds located north of the site, north of Long Sand Shoal (Figure 1-1).

While it is unlikely that the dominant east-west tidal flow would transport suspended sediment northward from the disposal site, these concerns warranted further investigation of the dynamics of sediment transport at the site. A plan for monitoring this dispersive site was developed (Figure 1-2), and the first phase of investigation was defined. The first phase was based on the assumption that, if material were transported out of the disposal site, it would mix with, and ultimately settle with, the larger volume of ambient sediment cycling within the Sound. Since far-field tracking would be difficult due to the mixing with, and dilution by, background sediments, the first goal was to determine if field-observed transport at the disposal site is consistent with the predicted east-west transport.

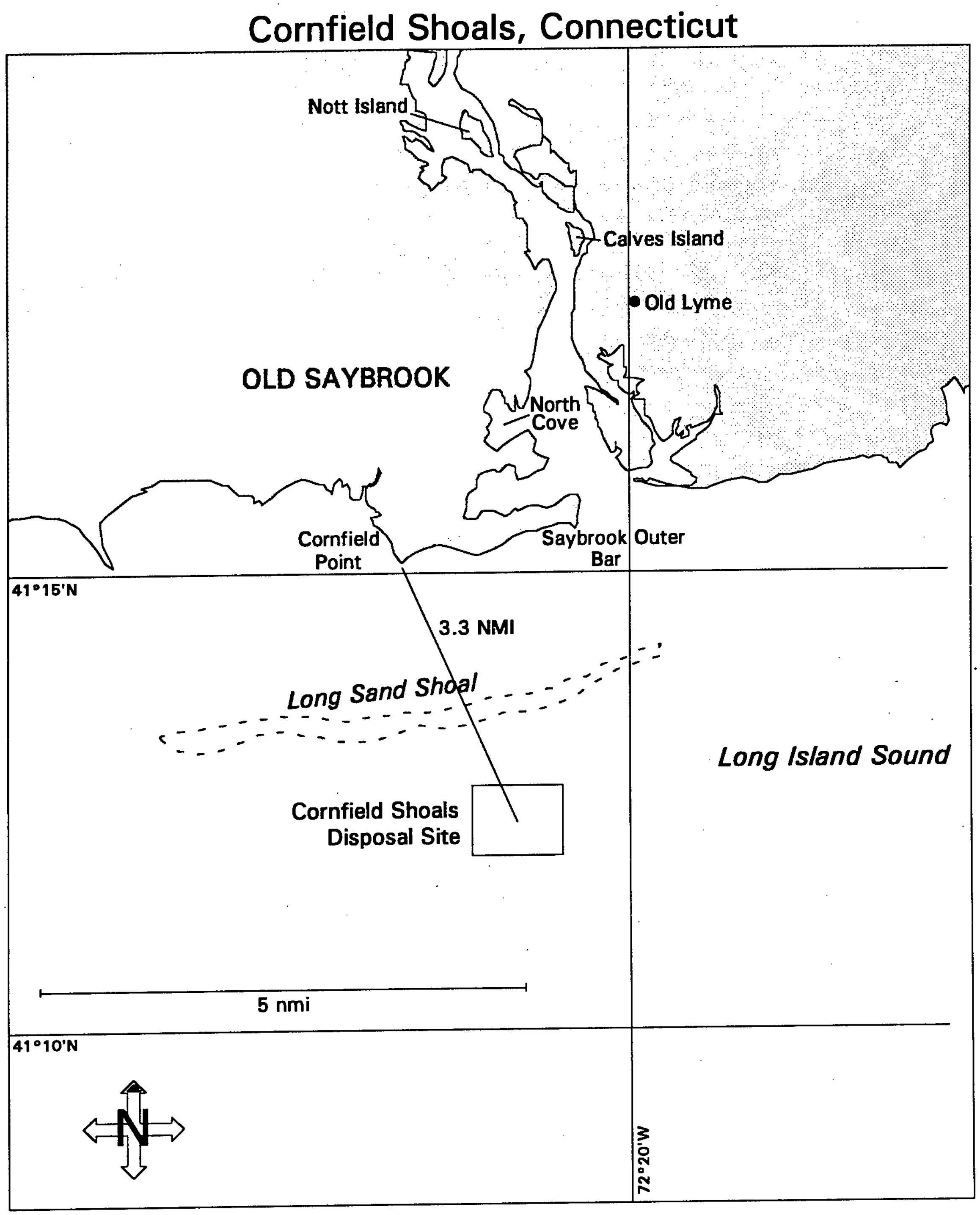
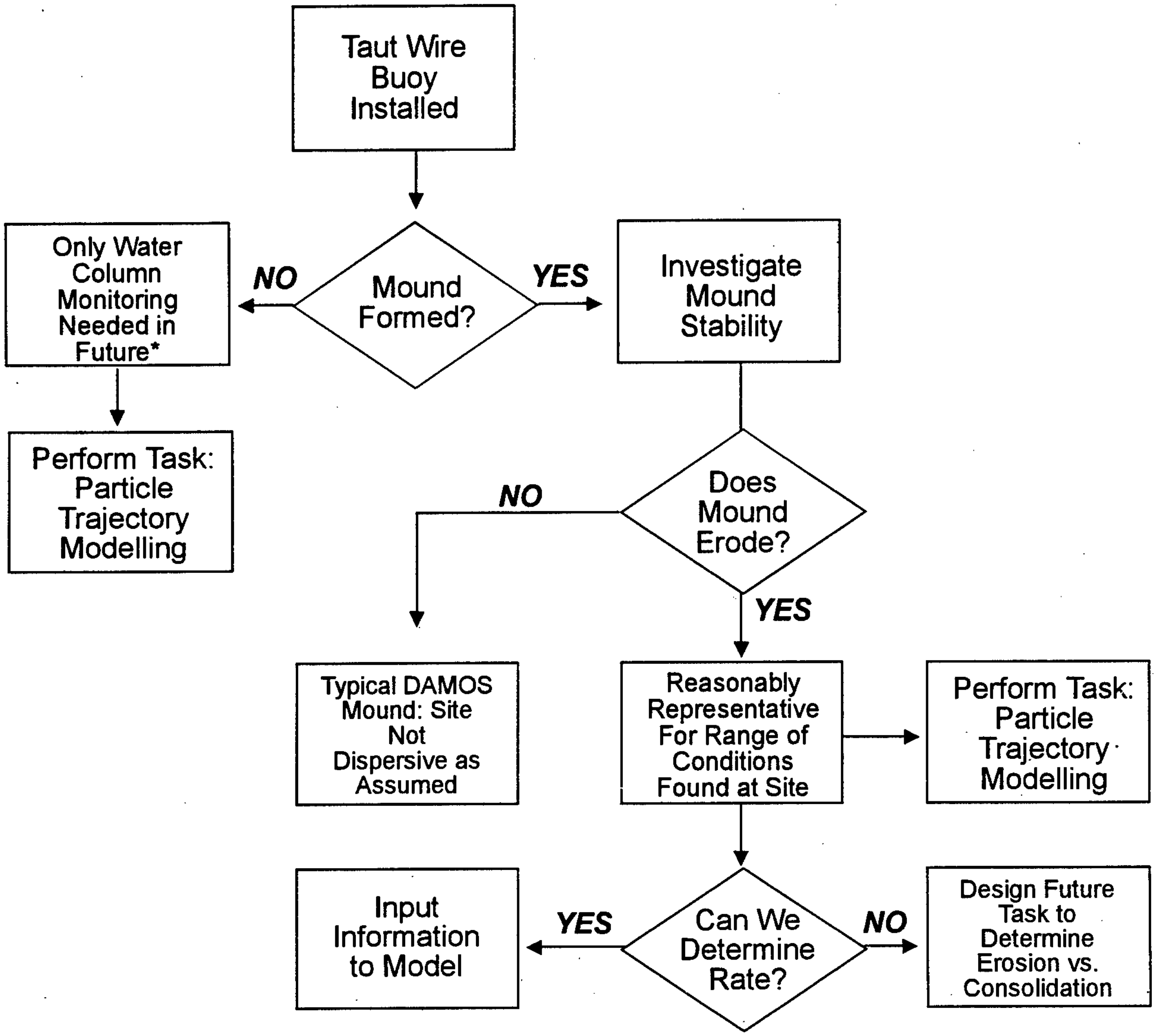


Figure 1-1. Location of CSDS



* Under these flow conditions with this type of material.

Figure 1-2. Preliminary CSDS Monitoring Plan

To determine the behavior of sediments at the disposal site, this study was designed to answer the following questions:

1) Will the material released at CSDS over a period of several weeks form a discrete mound?
2) Assuming a mound does form, at what rate does erosion dissipate the mound?
3) What currents would transport material away from the site, and what are the primary directions of transport?

While this study cannot directly address question 3, field data from this study provide evidence for predicting two-dimensional transport. If these data are to be incorporated into particle trajectory modeling for a more refined determination of the fate of suspended particles, more information on three-dimensional dynamics needs to be obtained. With model-determined transport patterns, investigations can be designed that could verify the currents required to transport material out of CSDS, and the directions of transport. However, a more immediate goal is to determine the effects of dredging (i.e., by different methods) and disposal conditions on the dynamics of dredged materials at CSDS.

The planned disposal of fine-grained material from North Cove, Connecticut provided an opportunity to observe the dynamics of mechanically dredged materials. The initiation of hydraulic dredging of sand from channel bars in the Connecticut River before North Cove allowed an unexpected comparison with the North Cove project. By studying two distinct dredging projects, the ability to determine mound erosion rates was limited to "before and after" bathymetric surveys. However, by including both projects we could evaluate the dynamics of the two types of materials disposed at this site.

2.0 METHODS

The study team used bathymetric surveys, REMOTS® sediment-profile photography, and current meter moorings with transmissometers and optical backscatter sensors to ascertain whether material was accumulating and/or eroding, and likely directions of sediment transport (Table 2-1). By conducting a series of four bathymetric surveys over the study area - one before, two during, and one after dredged material disposal - SAIC was able to determine where material had collected during the disposal operation and where material had been lost. SAIC also used REMOTS® sediment-profile photography to help delineate the presence of dredged material and small scale (<20 cm thickness) sediment structures that may indicate sediment transport. Current strength and direction were measured near the bottom and at mid-depth using moorings supporting a single current meter deployed by UCONN's team. Suspended sediment concentration was measured by UCONN's DAISY (Disposal Area In Situ System), comprised of a transmissometer and optical backscatter sensor mounted on the bottom structure supporting the current meter.

Dredged materials were released at two different locations at CSDS in 1991-92 to permit observations of distinct disposal projects. The current meter mooring that housed the near-bottom current meter was located in conjunction with the disposal buoy. The chronology of buoy and mooring deployments and their location are shown in Table 2-1 and in Figure 2-1.

2.1 Bathymetry

The four bathymetric surveys were conducted between August 1991 and May 1992 at the following times:

1. Before the disposal season (8 August 1991),
2. After disposal of sandy dredged material from Connecticut River bars at buoy location A (18 and 19 October 1991),
3. During disposal of fine-grained North Cove sediments at buoy location B (10 December 1991), and
4. After disposal was completed (May 1992).

The bathymetric surveys were set up over a 1200 × 1200 m grid (49 lanes at 25 m lane spacing) centered on the first disposal buoy (location A, Figure 2-1). The August, October, and May surveys were completed over the whole grid. The December bathymetric survey included only the northern 30 lanes due to bad weather. During analysis of the August, October, and December surveys, the grid area was reduced to 1000 × 1000 m to correspond with the 1987 survey and correct for irregularities in the tidal estimations and roll of the ship. The May 1992 survey data were processed by the SAIC Hydrographic Data Analysis System (HDAS) and did not require comparison to the 1987 data.

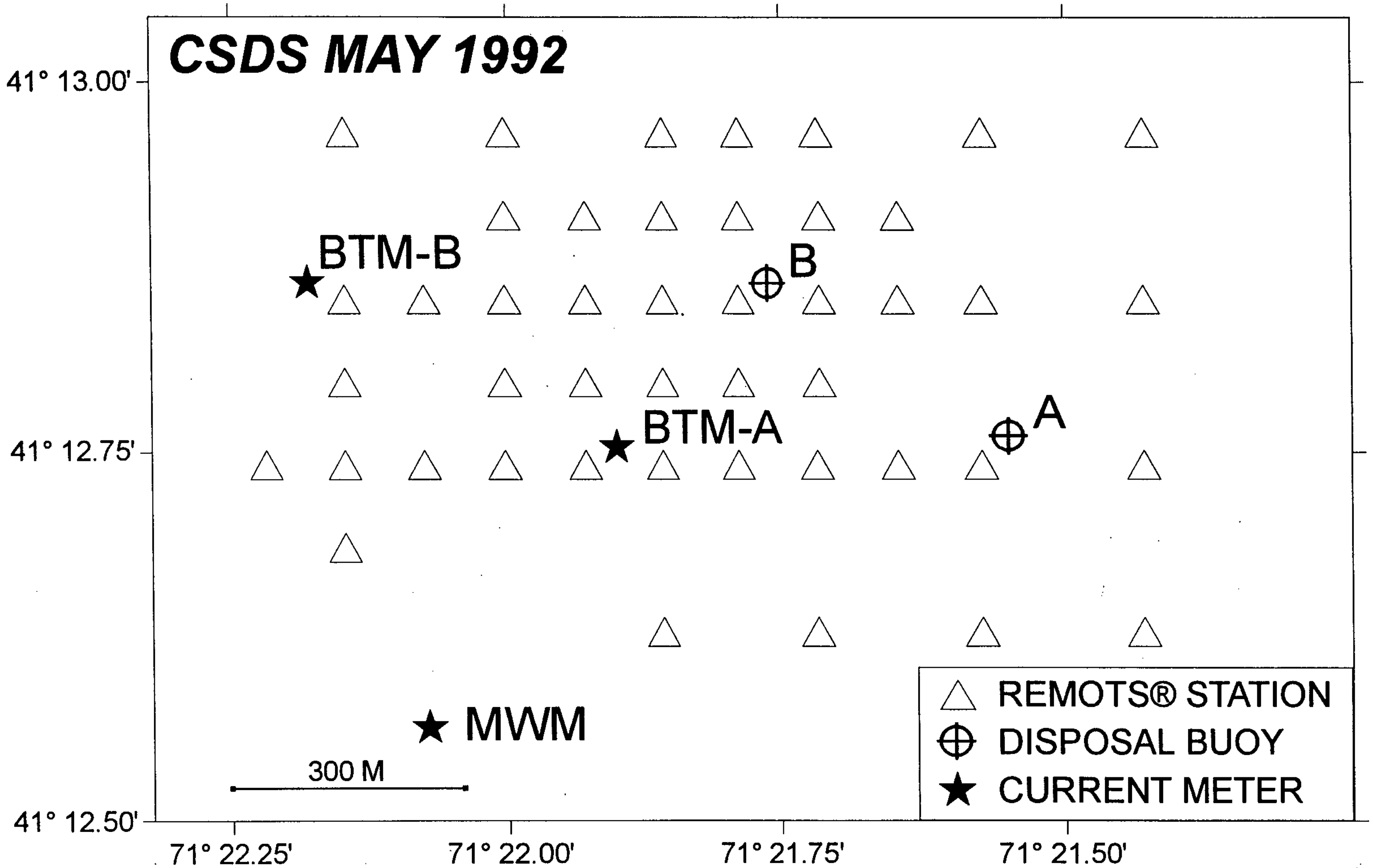


Figure 2-1. Locations of disposal buoys, current meter moorings, and the May 1992 REMOTS® stations at CSDS

Table 2-1

Summary of Disposal and Monitoring Activities at CSDS, June 1991 to May 1992

Date	Action	Position
June 23	Disposal buoy "A" located	41°12.69′ N, 72°21.54′ W
July 18	Bottom Meter A (BTM-A) deployed	41°12.75′ N, 72°21.88′ W
August 1 August 8 August 8 August 13	Mid Water Meter (MWM) deployed Bathymetric survey "A" disposal buoy relocated Daisy deployed at BTM-A	41°12.57′ N, 72°22.108′ W 41°12.75′ N, 72°21.55′ W 41°12.75′ N, 72°21.88′ W
September 12-18 September 20-25	Saybrook Outer Bar dredged (sand, 19,906 m^3) Calves Island Bar dredged (sand, 15, 597 m^3)	
October 1-9 October 18-19 October 18 October 21	Essex and Nott Island Bars dredged (sand, 15,300 m^3) Bathymetric survey Disposal buoy relocated to B BTM-A retrieved, BTM-B deployed at	 41°12.85′ N, 72°21.76′ W 41°12.83′ N, 72°22.16′ W
November 13	North Cove dredging begun (silt)	
November 27	DAISY retrieved	
December 10 December 10 December 10	Bathymetric survey Disposal Buoy located due to drifting at Disposal Buoy relocated to B	 41°12.81′ N, 72°22.08′ W 41°12.85′ N, 72°22.76′ W
December 12	Final data retrieval from BTM-B and MWM	
January 9	BTM-B and MWM removed from site	
April 14	North Cove dredging concluded (105,479 m^3)	
May 12-13	Bathymetric and REMOTS® surveys	

The SAIC Integrated Navigation and Data Acquisition System (INDAS) provided the precision navigation required for all bathymetric and REMOTS® field operations. Shore stations for CSDS surveys were at known benchmarks at Cornfield Point (41°15.79′ N, 72°23.04′ W) and Lynde Point Light (41°16.29′ N, 72°20.59′ W) in Old Saybrook, CT. An Odom DF3200 Echotrac® Survey Recorder with a narrow-beam 208 kHz transducer recorded depth to a resolution of 3.0 cm (0.1 feet) as described in DAMOS Contribution No. 48 (SAIC 1985). Contribution No. 60 (SAIC 1989) contains a detailed description of INDAS and its operation as well as the bathymetric analysis technique.

2.2 Current and Suspended Sediment Measurements

During the 1991 surveys, two moorings were deployed at CSDS (Bohlen et al. 1992). One mooring (BTM) was equipped with a single InterOcean Systems, Inc. S4 current meter, two 10 cm pathlength red-light transmissometers, and a single red-light optical backscattering sensor (D&A OBS-1 Sensor) located approximately one meter above the bottom. The second mooring (MWM) was equipped with a single S4 current meter positioned 11 m below the sea surface. These two current meters measured the direction and magnitude of the currents. The transmissometers and optical backscatter sensors attached to the near-bottom current meter (BTM) measured suspended sediment concentrations. All the moored instruments burst sampled 4 times an hour at a rate of twice per second for one minute.

On June 23, 1991, the A disposal buoy was deployed at 41°12.69′ N, 72°21.54′ W. The near-bottom mooring (BTM-A) was positioned approximately 500 m northwest of this buoy on July 18. The water depth at BTM-A was approximately 53 m, and the instrument package was located one meter above the seafloor. A mid-water mooring (MWM), with a S4 current meter 11 m below the surface, was deployed southwest of BTM-A on August 1 (Table 2-1, Figure 2-1). Buoy A was moved north to its final location (41°12.75′ N, 72°21.10′ W) on August 8, prior to the start of disposal to further separate the disposal location from a previously used location to the south (Table 2-1, Figure 2-1). On August 13, the optical backscatter sensor and transmissometer package (DAISY) was added to the bottom mooring (BTM-A). After the Connecticut River bars dredging was completed, the disposal buoy was relocated on October 18 to location B (Table 2-1, Figure 2-1). The near-bottom current meter mooring (BTM-B) was moved approximately 500 m to the west of B on October 21. The water depth at BTM-B was approximately 53 m. Again, the instrument package was housed one meter above the bottom. The DAISY instrumentation was removed from BTM-B on November 27th. A mid-water mooring, with a current meter positioned 11 m below the water surface, remained at the same location for the duration of the study. The last data retrieval for BTM-B and MWM was December 12, 1991. The moorings were removed from the water on January 9, 1992.

2.3 REMOTS®

A REMOTS® survey was conducted at CSDS on May 12 and 13, 1992. The REMOTS® sampling grid was designed to define the limits of dredged material distribution at CSDS. The grid encompassed disposal locations A and B and consisted of 22 stations spaced 200 m apart. Seven additional stations spaced 100 m apart were concentrated around the dredged material deposit at B after it was detected during the bathymetric survey. After reviewing the REMOTS® photographs from these 29 stations for the presence of dredged material, an additional 16 REMOTS® stations were sampled to define further the boundary between dredged material and ambient sediment (Figure 2-1). Three replicate photographs were taken at all REMOTS® stations.

3.0 RESULTS

3.1 Bathymetry

All four bathymetric surveys at CSDS (August 1991, October 1991, December 1991, and May 1992) show a seafloor that slopes from north to south, and a northeast/southwest trending trough in the southern half of the survey area. All disposal locations were located on the northern slope.

The August 1991 bathymetric survey (Figure 3-1) was conducted prior to the 1991/1992 disposal season. There was no evidence in the bathymetric plot of any previous disposal mound at the site. The next bathymetric survey was conducted on October 18 and 19, 1991 after about 53,800 m^3 of sandy/silty dredged material was released at buoy A (Figure 3-2). Again there was no distinct mound on the contour plots, but the depth at the disposal location decreased from approximately 54 m to 53.5 m.

A depth-difference plot, showing relative changes between the August 1991 and the October 1991 surveys showed up to 1 m of material accumulated over wide areas northwest and south of A. Between these areas of accumulation there were losses of up to 1 m of material (Figure 3-3).

After the October 1991 bathymetric survey the disposal buoy was relocated to position B. Fine-grained dredged material was removed from North Cove and released at buoy B starting November 13. Between November 13 and December 10, 1991, 13,891 m^3 of material was released at CSDS. When the survey was conducted (December 10), the disposal buoy was located west of its initial location. However, positions noted on the barge logs indicated that the barges continued to release material at the original (intended) B location (Figure 3-4). The December 1991 bathymetric survey did not indicate any well-defined accumulation of material at buoy location B (Figure 3-5).

A depth-difference comparison of the December and October, 1991 bathymetric surveys did not indicate any accumulation at buoy B (Figure 3-6). Instead, material accumulated to the west of B, and approximately 100 m south of buoy A. A loss of material appeared further south, the same area where material accumulated between August and October (Figure 3-3).

Between December and May, about 91,588 m^3 of fine-grained material was released at buoy B. The May 1992 bathymetric survey shows the same north-to-south sloping seafloor with a northeast/southwest trending trough in the southern half of the study area (Figure 3-7). In contrast to the 1991 surveys, the May data show a decrease in depth just north of the B buoy where the contours bend to the south. A depth-difference comparison

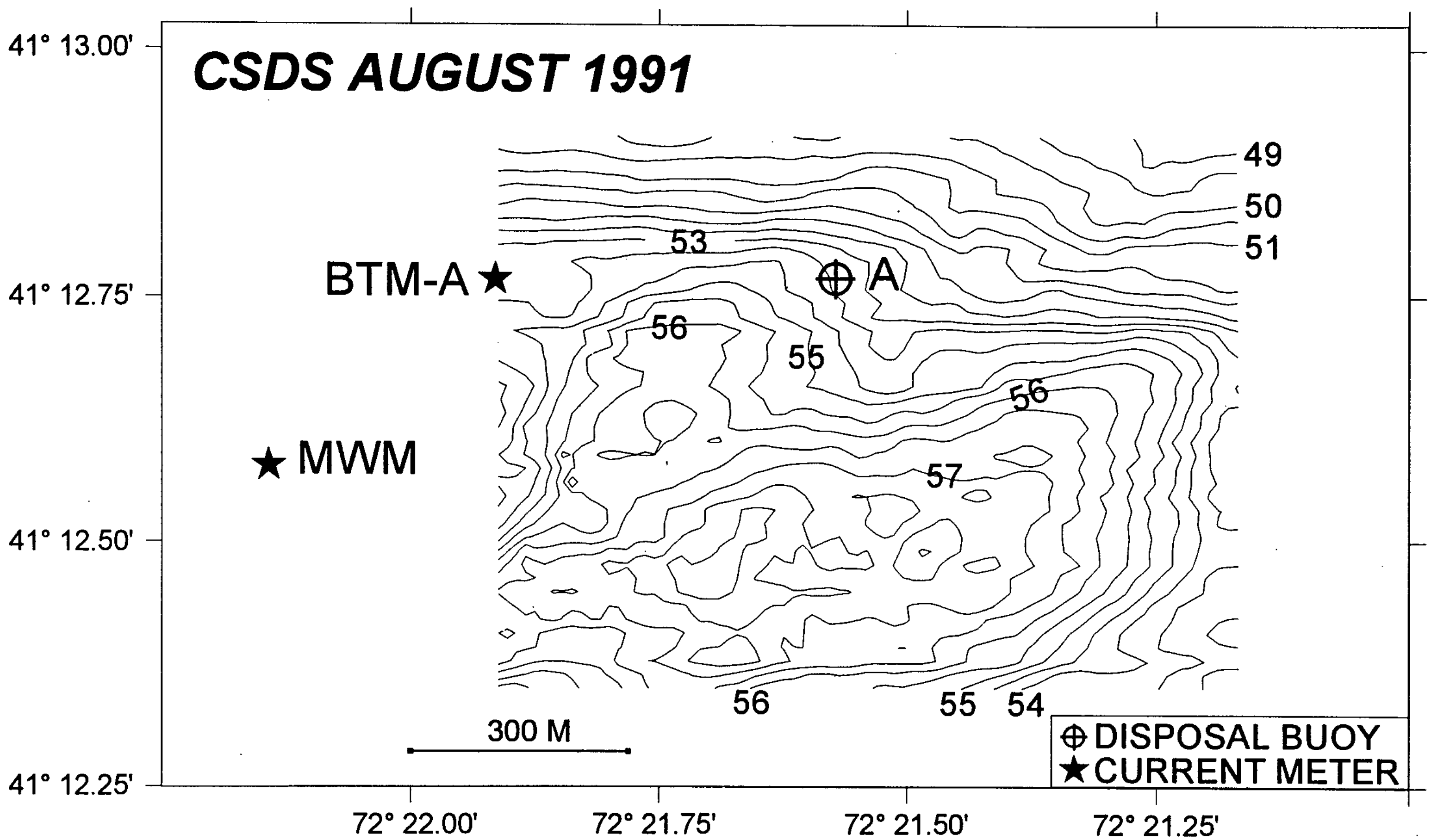


Figure 3-1. Predisposal bathymetric contour plot at CSDS, August 8, 1991 (depth in meters)

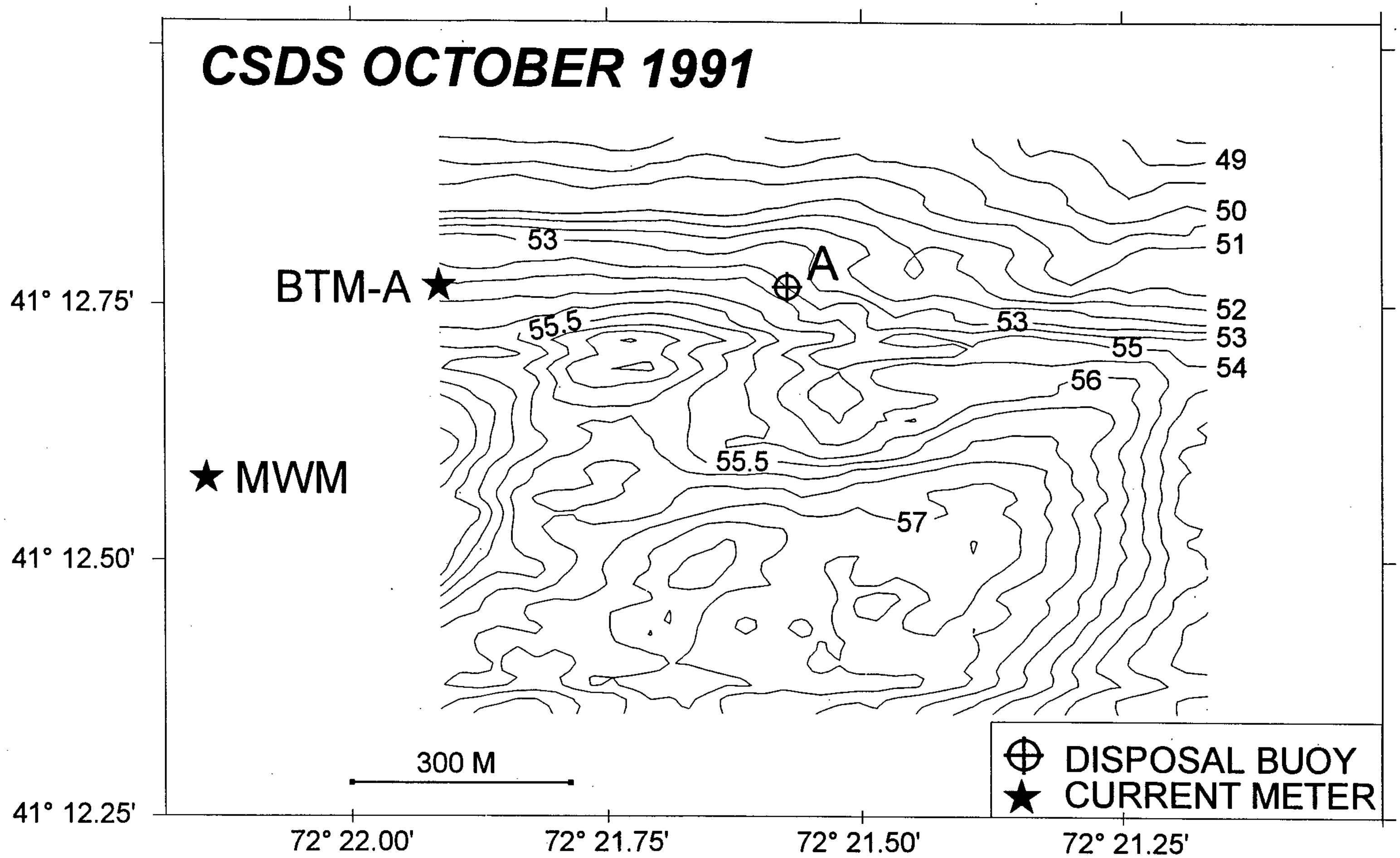


Figure 3-2. Bathymetric contour plot at CSDS after completion of Connecticut River dredging and disposal, October 18 and 19, 1991 (depth in meters)

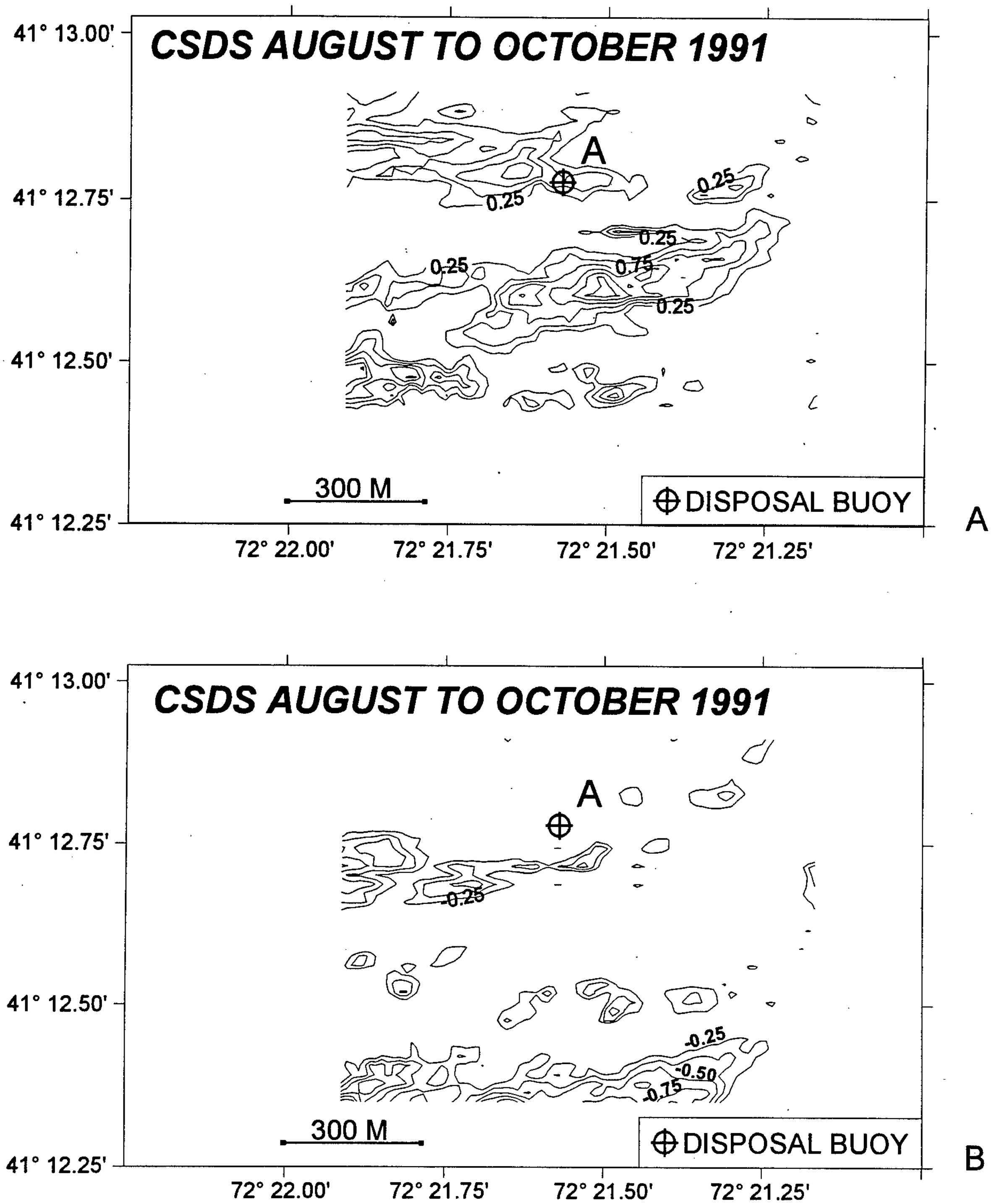


Figure 3-3. Accumulation (A) and erosion (B) at CSDS, August 8, 1991 to October 18 and 19, 1991 (depth in meters)

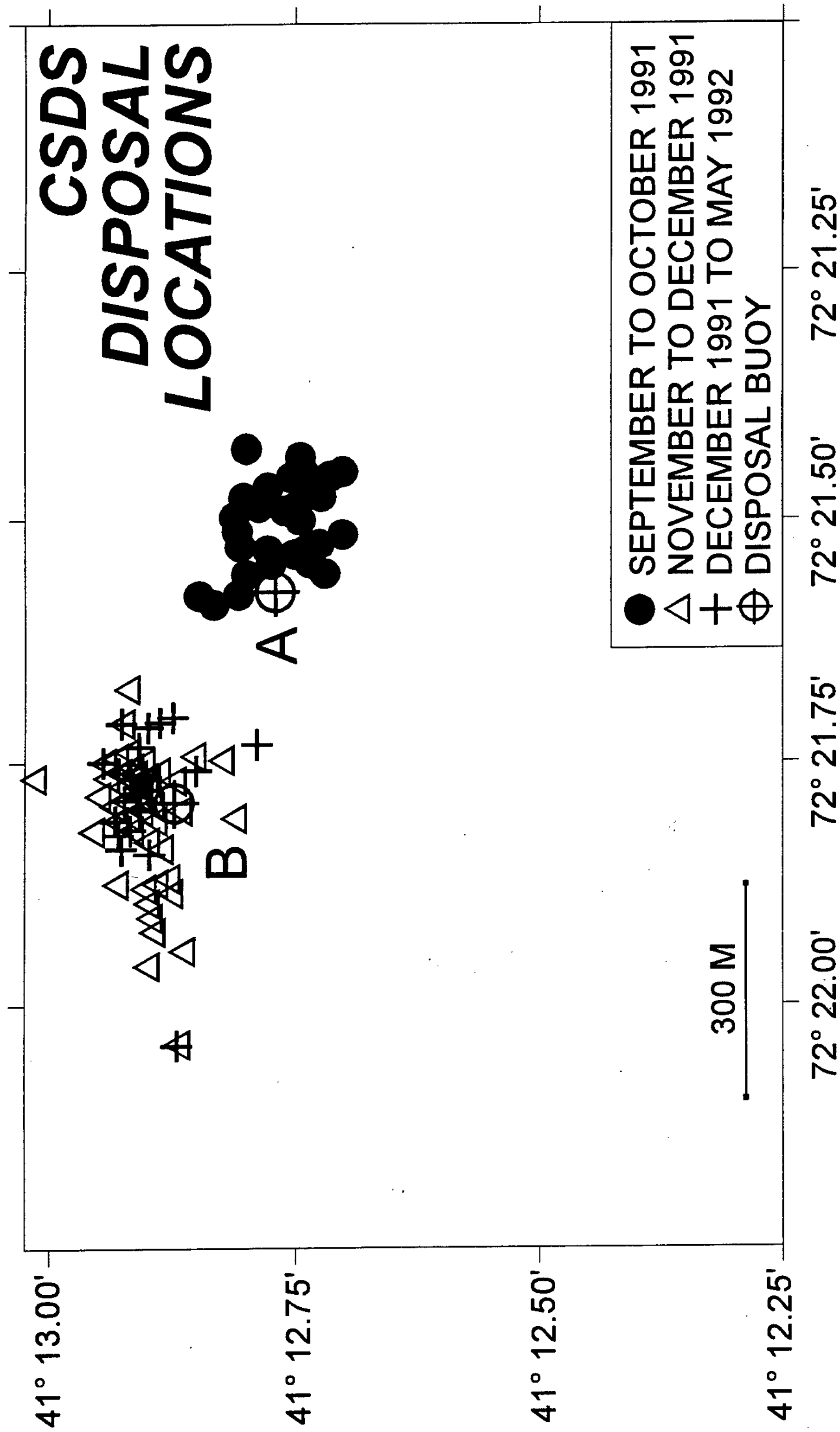


Figure 3-4. Barge release locations at CSDS, September 1991 to April 1992

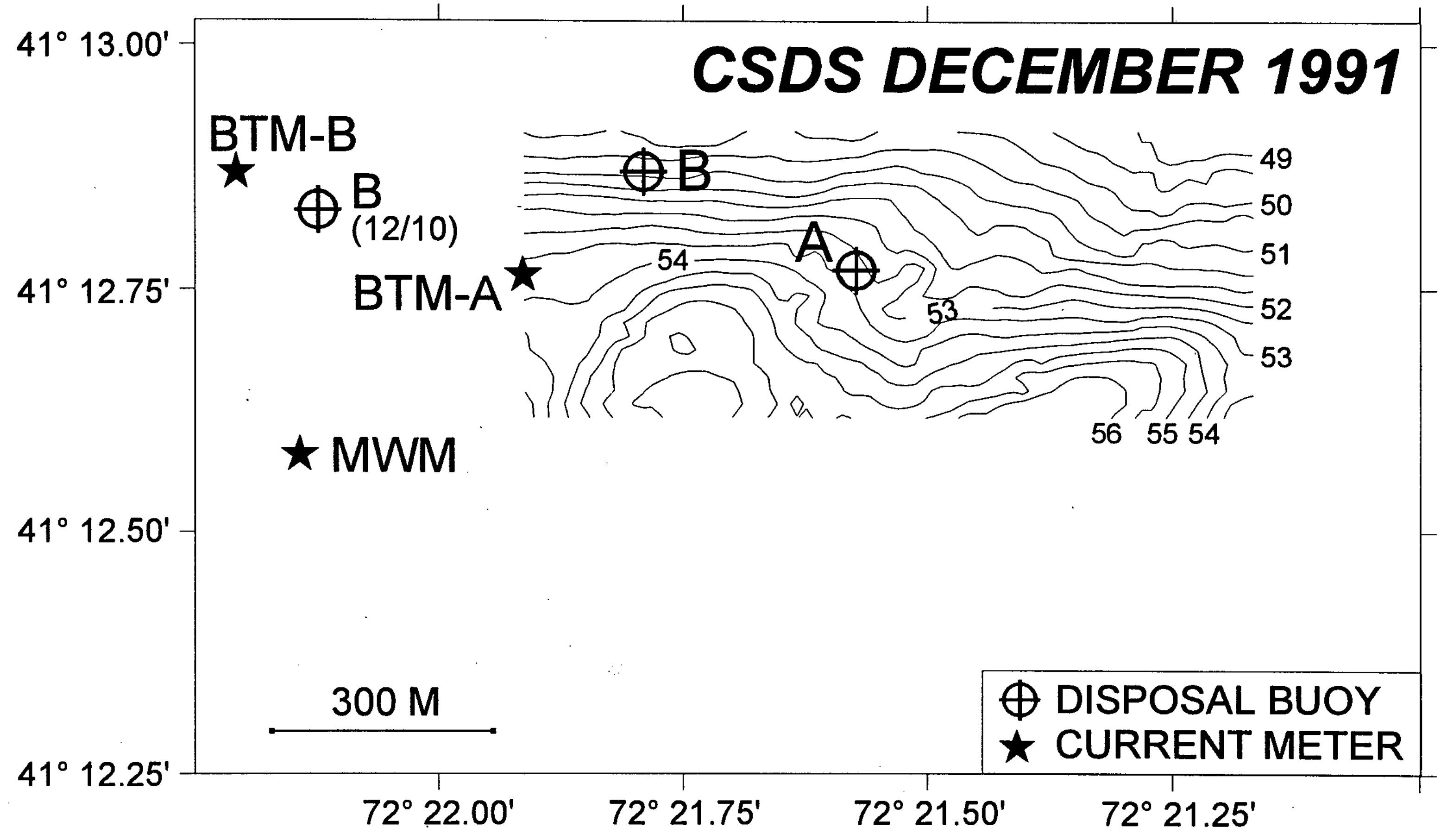
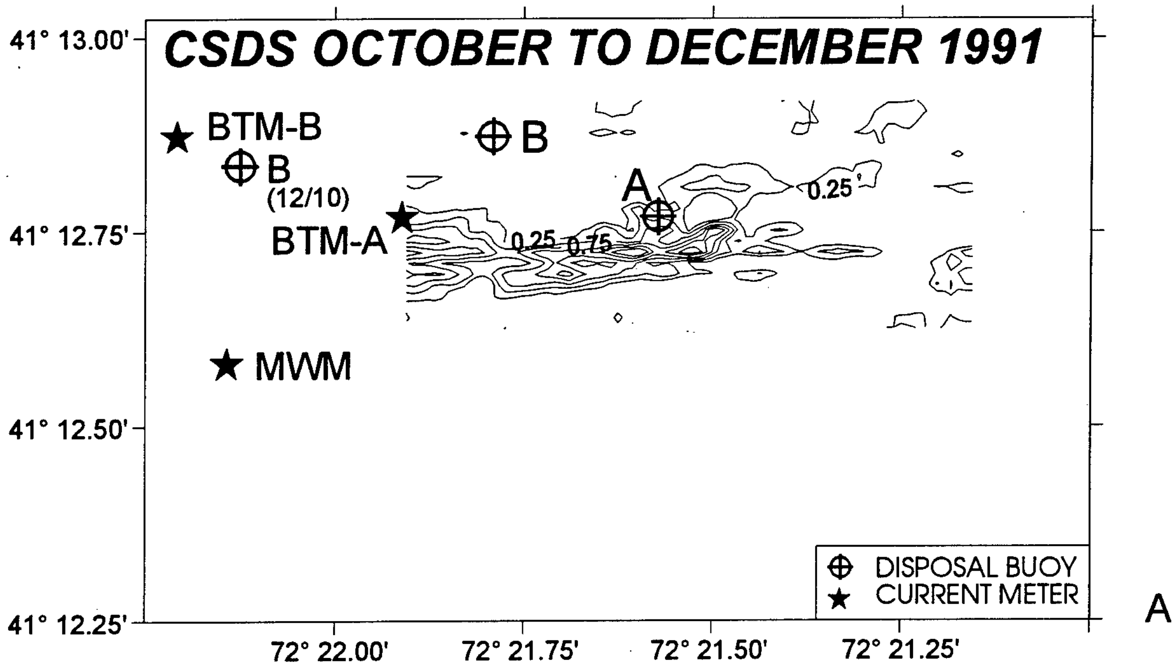


Figure 3-5. Bathymetric contour plot at CSDS during dredging and disposal of North Cove sediment, December 10, 1991 (depth in meters)



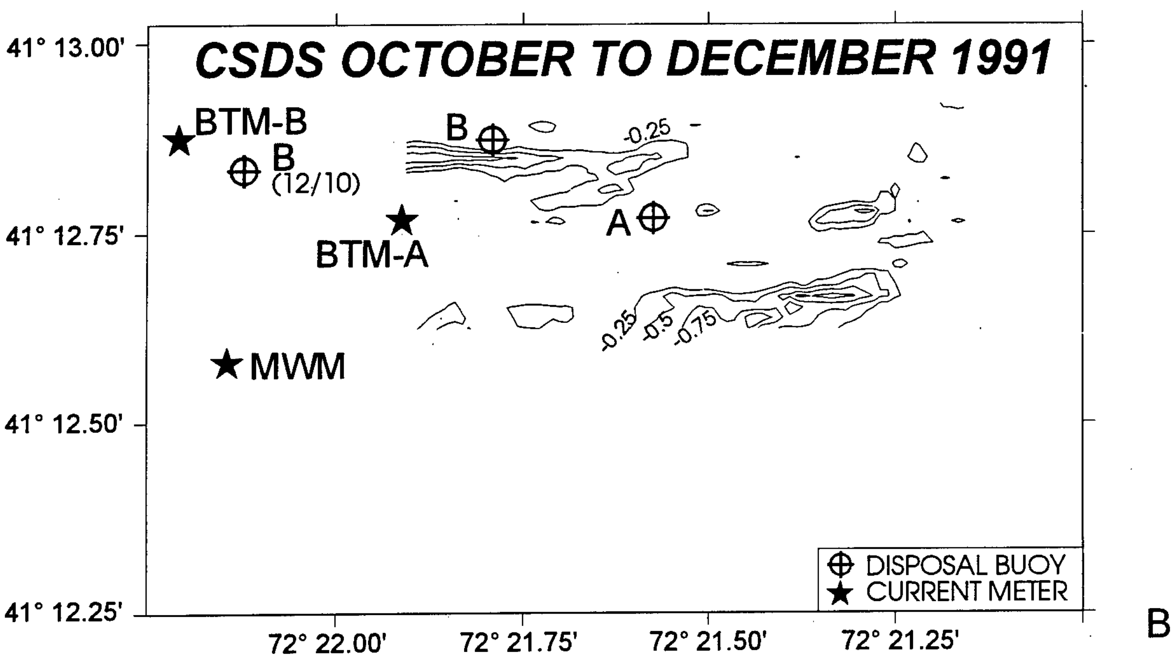


Figure 3-6. Accumulation (A) and erosion (B) at CSDS, October 18 and 19, 1991 to December 10, 1991 (depth in meters)

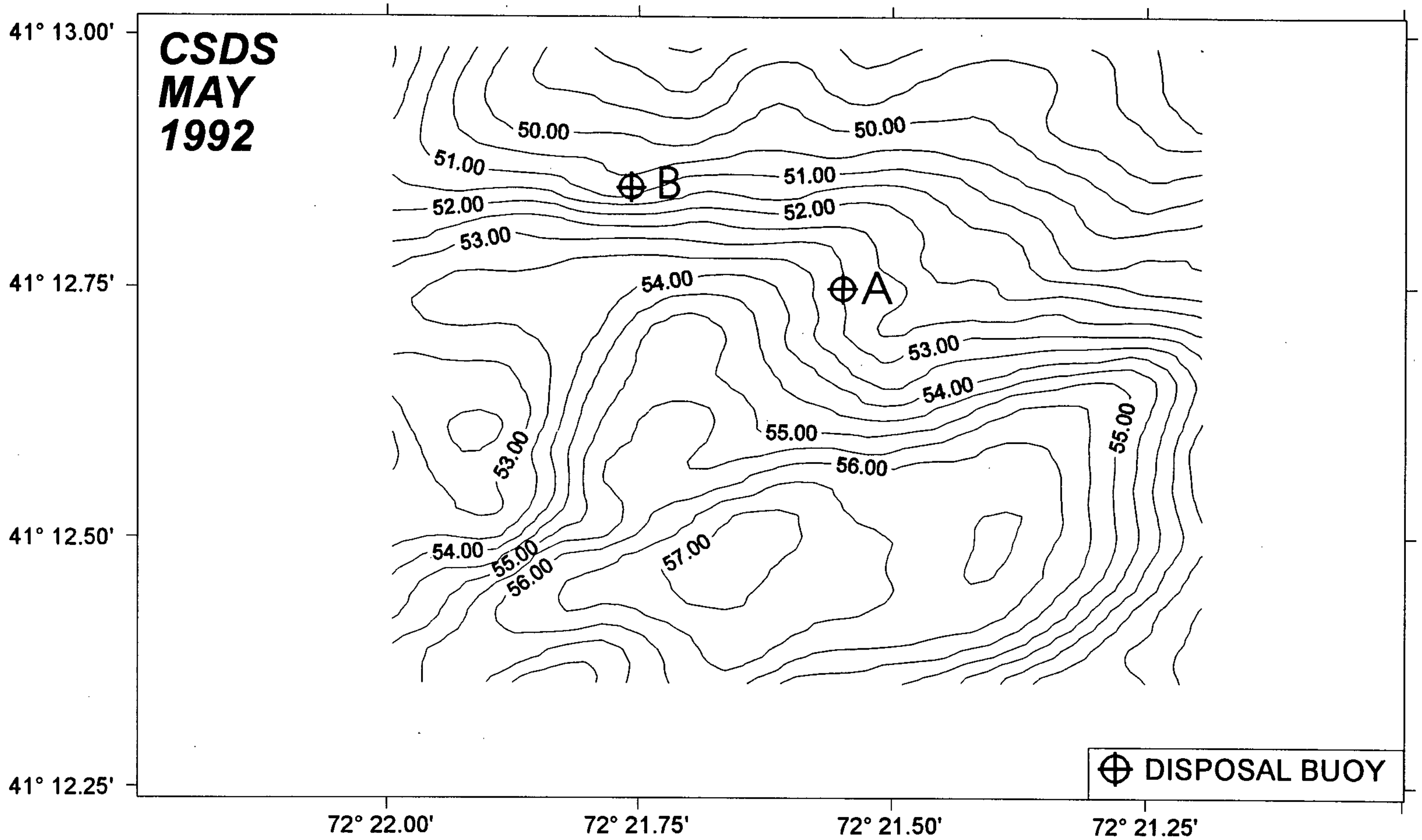


Figure 3-7. Bathymetric contour plot at CSDS after completion of North Cove dredging/disposal, May 12, 1992 (depth in meters)

between the December 1991 and May 1992 bathymetric surveys showed that 0.5 m of material accumulated at the B buoy location (Figure 3-8).

To illustrate the full extent of any erosion of the material dredged from the Connecticut River bars, and any deposition during the disposal of fine-grained material, a comparison was done of depths between the October survey (following completion of the sand disposal) and the May survey (following completion of the fine-grained disposal). Losses of material between October and May are in the same area and the same amount as between October and December. Accumulations during that time are just south of 41°12.75′ N, and at the B disposal location (Figure 3-9). The accumulation south of 41°12.75′ N is the same amount of material that had accumulated between October and December.

3.2 Current Meter Data

The mid-water and near-bottom current meters deployed at CSDS measured current direction and velocity from August 1 to December 12, 1991. A data report by Bohlen et al. (1992) contains a detailed discussion of these data. In both the mid-water and the near-bottom data, the tidal/current direction was dominated by the semi-diurnal east-west component. For the mid-water data, the vectors were 270° on the flood tide and 95° on the ebb. Near-bottom current directions were similar to the mid-water ebb current but shifted slightly to the northwest on the flood at BTM-B. There was more variability in the current direction at near-bottom (Figure 3-10). The east-west directions for both mid-water and bottom currents were parallel to the axis of Long Sand Shoal to the north (Figure 1-1).

The current velocities at CSDS were maximum during the flood portion of the tidal cycle. Over the long term (monthly time scale), maximum mid-water velocities were about 120 $cm \cdot s^{-1}$ on the spring tide and 60 $cm \cdot s^{-1}$ on the neap. At the near-bottom station, maximum velocities were about 80 $cm \cdot s^{-1}$ on the spring tide and 40 $cm \cdot s^{-1}$ on the neap. In all cases, these current velocities would be sufficient to erode fine to medium sands. For the near-bottom current, the flood tide velocities were highest. This resulted in a net westward trajectory for particles as they approached the bottom.

With the tidal variability removed from the current meter data at the mid-water station, current vectors trended north and west. The combined net drift for the mid-water current was 305° true at 4.65 $cm \cdot s^{-1}$. For the near-bottom meters, removal of the tidal variability resulted in a south and west component with a combined net drift of 256° true at 8.33 $cm \cdot s^{-1}$.

During the current meter deployment at CSDS, two major storms passed over the area. Hurricane Bob passed over Long Island Sound on August 19, 1991 and produced maximum wind speeds of 45 knots. During the hurricane, the near-bottom current meter

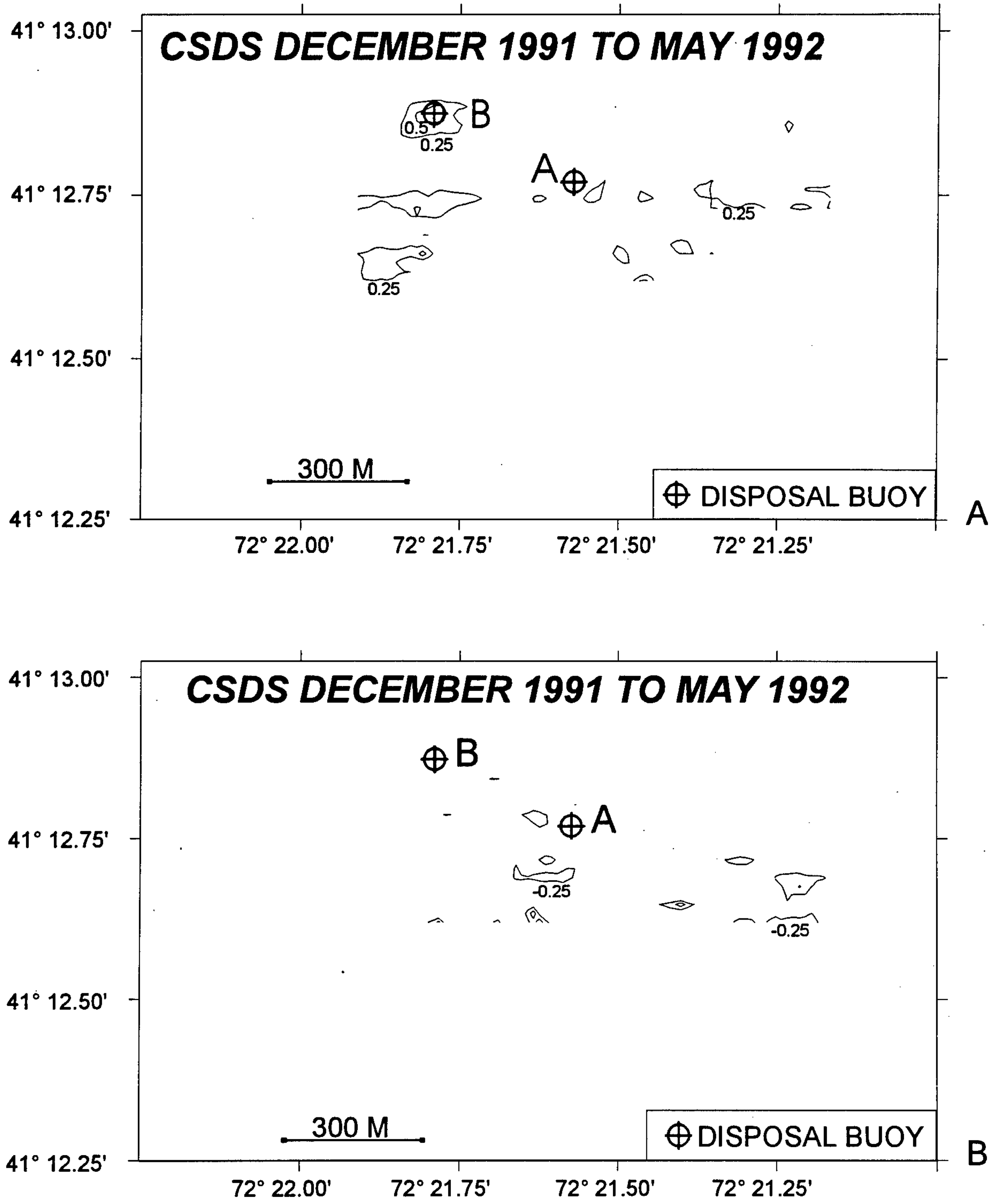


Figure 3-8. Accumulation (A) and erosion (B) at CSDS, December 10, 1991 to May 12, 1992 (depth in meters)

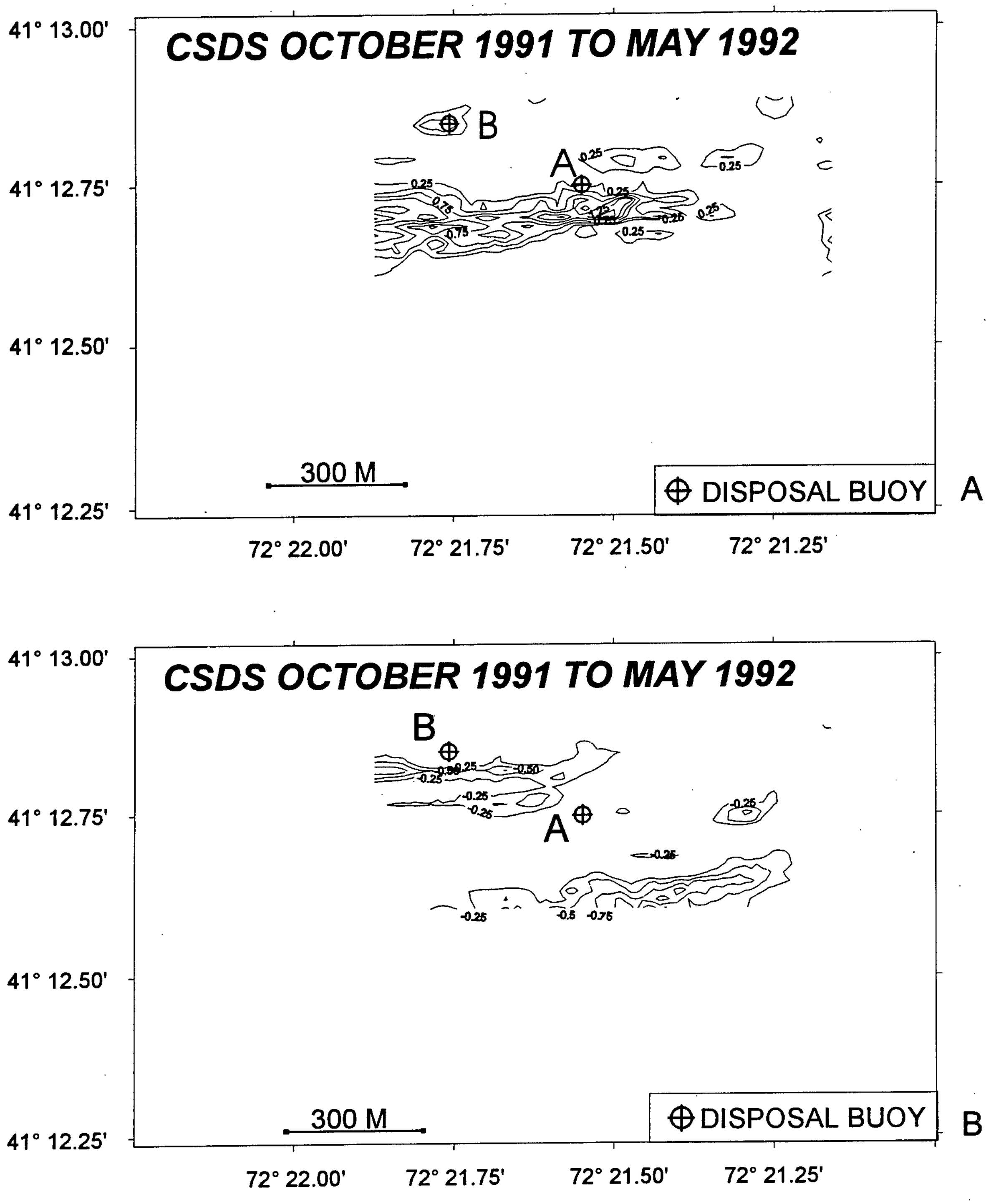


Figure 3-9. Accumulation (A) and erosion (B) at CSDS, October 18 and 19, 1991 to May 12, 1992 (depth in meters)

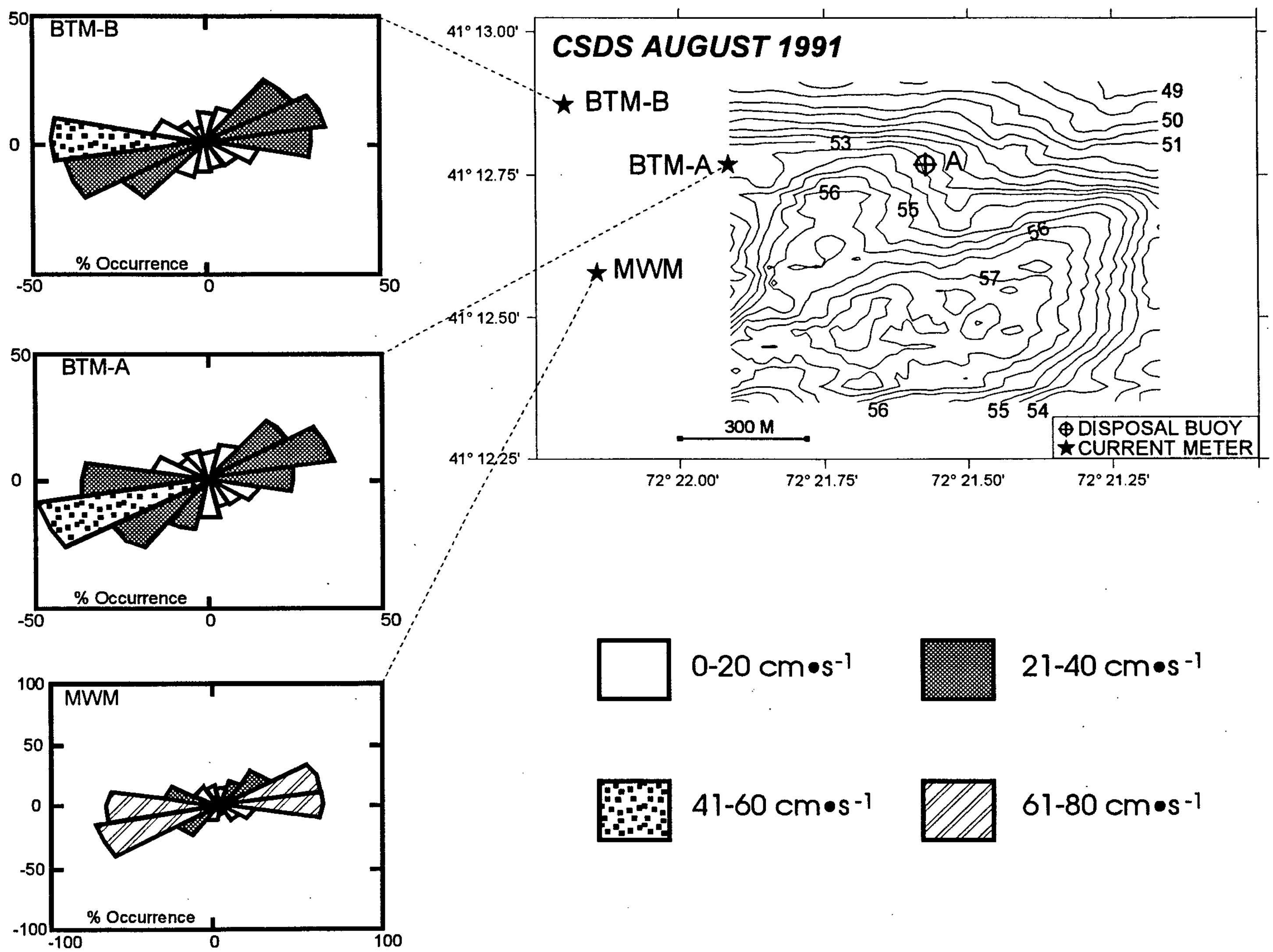


Figure 3-10. Current meter data with mooring locations for bottom mooring A (BTM-A), bottom mooring B (BTM-B), and the mid-water mooring (MWM)

was on its side, and data were not obtained; the data from the mid-water meter showed that the mid-day flood velocity was reduced by more than half. The succeeding flood tide current was normal. The near bottom current meter was operational between August 28th and September 26th, and again between October 21st and December 12th. At the end of October 1991, a major storm occurred that lasted 114 hours with sustained winds of 40 knots over October 30 and 31. The National Weather Service determined this to be a 100-year storm; therefore, the potential for erosion could have been high. During this "Halloween" storm, the current meters showed no change in current strength, yet change did occur in the net drift. The mid-water drift, normally 305° true, shifted to the west and then south for three days. The near-bottom current net drift, normally 256° true, shifted to the west. The combined effects of the October storm were to produce an offshore displacement in the mid-depth waters, and shoreward displacement of bottom waters, intensifying the rate of upwelling in the area.

3.3 Suspended Sediment Concentrations

Background levels of suspended sediment concentrations were measured at approximately 6.5 $mg \cdot l^{-1}$ prior to the release of dredged material at CSDS on September 12, 1991. There was a weak tidal dependence in the background suspended sediment concentrations. With the release of dredged material at buoy A, the background levels of suspended sediment, measured approximately 1 m above the seafloor, increased by an order of magnitude at BTM-A. The initially weak tidal dependence was increased with the advent of dredged material disposal. In addition to the general increase in water column turbidity during dredged material disposal, there were definite peaks during the discrete disposal events (Figure 3-11).

The background turbidity levels at BTM-A did not increase significantly until three days into the Saybrook Outer Bar disposal. Since the Saybrook Outer Bar contained medium to fine sands, the initial increases in suspended sediment concentrations were due only to discrete disposal events. As material accumulated on the seafloor, background levels increased, presumably due to tidal resuspension and winnowing. Once the material eroded or formed a lag deposit, the background turbidity levels began to decrease. A gradual, but lower magnitude increase in background levels occurred during disposal from the Calves Island Bar and Essex Island Bar projects. However, the amount of the resuspended material in the bottom water decreased, from the Saybrook Outer Bar to the Calves Island Bar and Essex Island Bar projects, as the material became coarser (Bohlen et al. 1992).

3.4 REMOTS®

The REMOTS® sediment-profile survey was conducted in May, after the completion of dredged material disposal at CSDS. The REMOTS® photographs detected dredged material at 15 out of 45 stations. Most of these stations were within 400 m of disposal

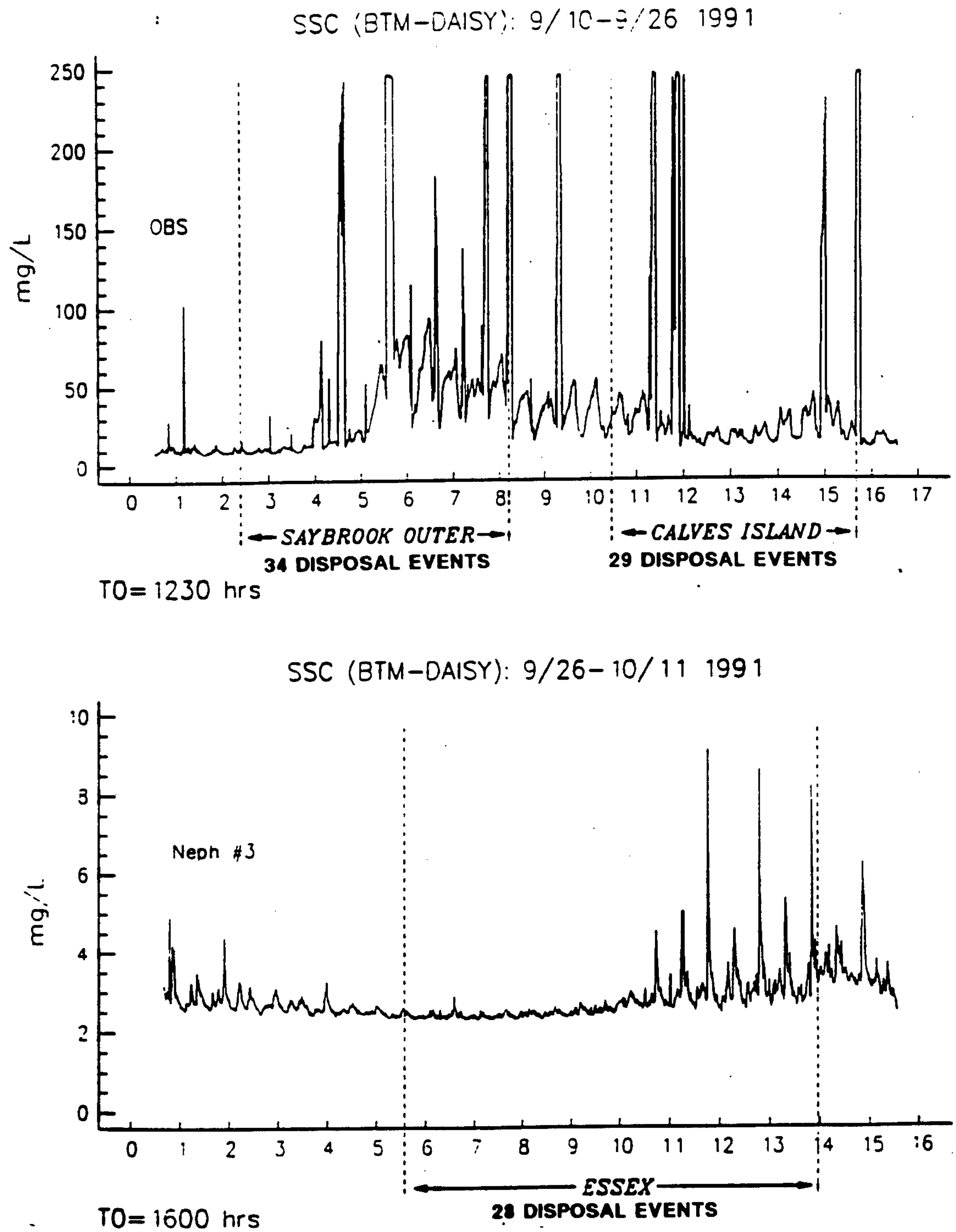


Figure 3-11. Suspended sediment concentrations at CSDS during disposal operations, September and October 1991

buoy B (Figure 3-12). The dredged material released at buoy location B, and detected in the REMOTS® survey, was fine-grained material from the North Cove project. At the disposal buoy location, very little sand covered the fresh dredged material (Plate 3-1). At progressively greater distances from the center of the disposal mound, a layer of sand covered the dredged material (Plate 3-2). This sand layer appeared to thicken with distance from the mound center (Figure 3-13). An exception was REMOTS® Station D3 where fresh dredged material was found with little or no sand cover. The presence of sand at a REMOTS® station limited the penetration depth of the camera prism. If there were areas in this REMOTS® survey where more than 4 to 5 cm of sand covered finer grained material, the camera did not penetrate the sediment far enough to detect it.

The ambient sediment detected in the REMOTS® photographs was either fine sand of a uniform grain size, or coarser sand with shell fragments and pebbles. The photographs of the fine sand sediment showed bedforms, or sand ripples, but there were no visible macrofauna (Plate 3-3). The sand ripples, approximately 1 to 3 cm in height, were concentrated south of 41°12.75′ N. REMOTS® photographs of the coarser grained sands contained shell fragments and pebbles with hydroids (Plate 3-4). The presence of hydroids on lag surfaces of shell and gravel was noted for an area approximately 2 nmi southwest of the disposal site in May 1987 (Fenster et al. 1990). Except for Station C13, sand ripples and shell fragment were mutually exclusive.

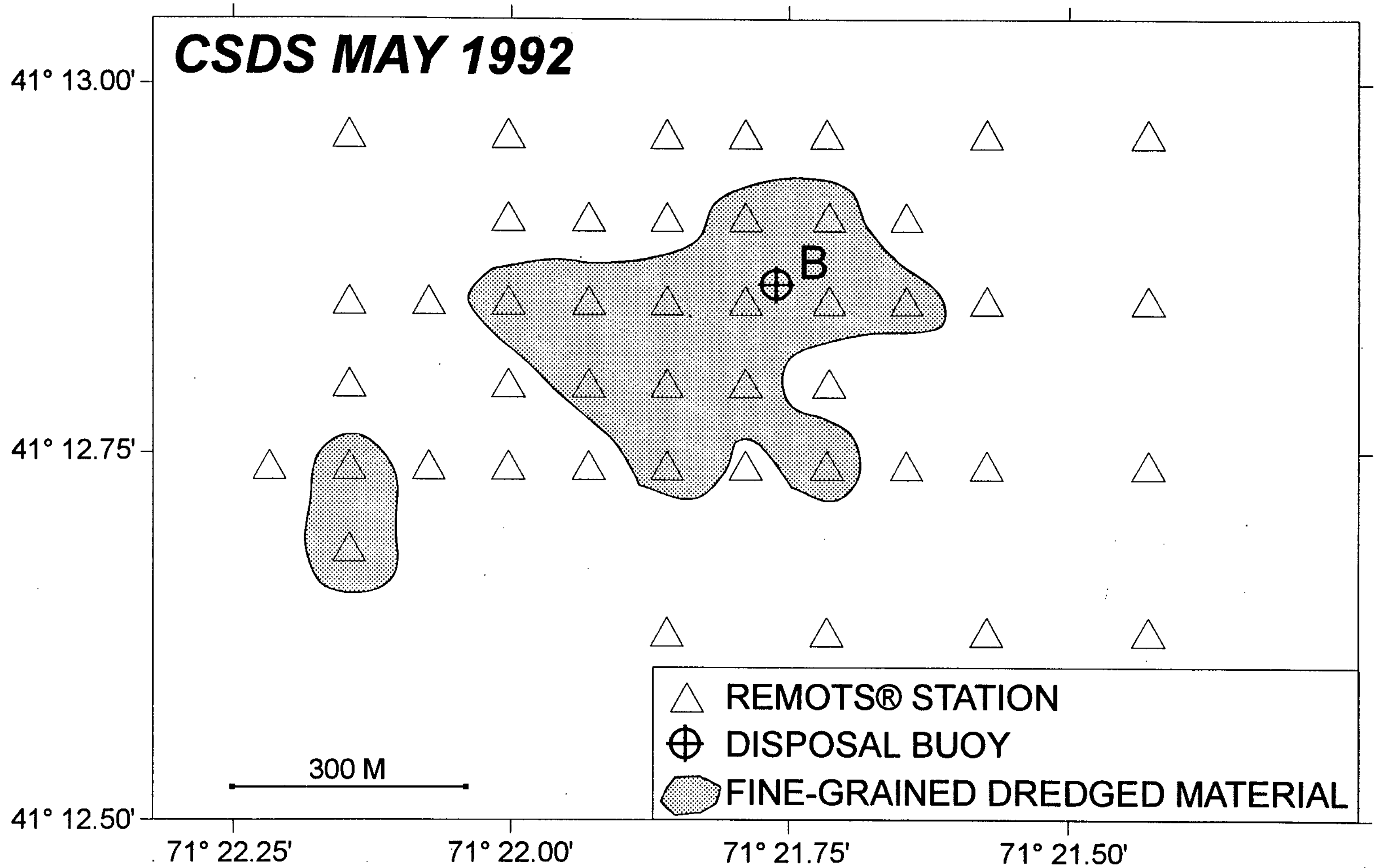


Figure 3-12. Distribution of fine-grained dredged material at CSDS as detected in REMOTS® photographs, May 12 and 13, 1992

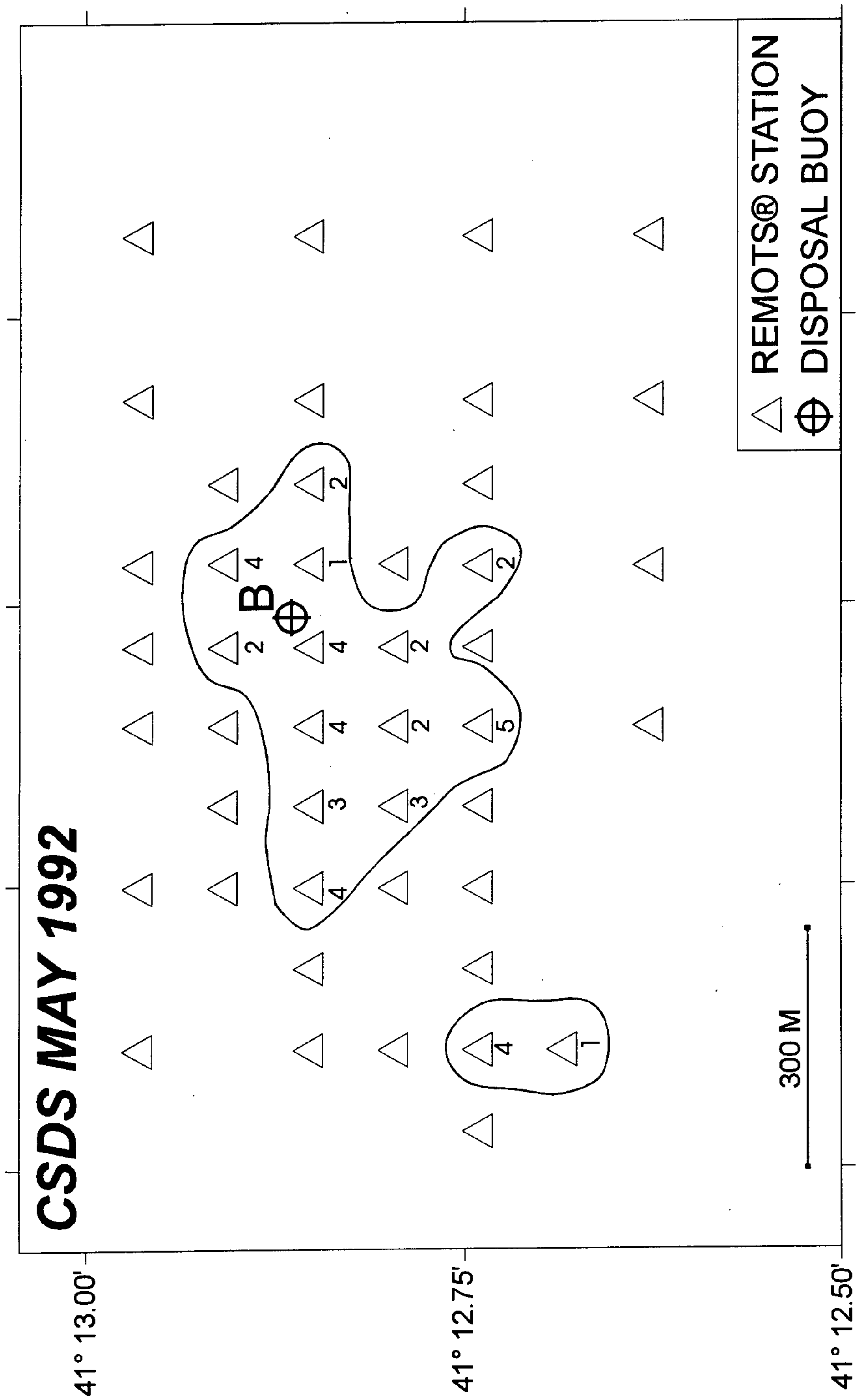


Figure 3-13. Thickness of sand layer over fine-grained dredged material at CSDS, May 12 and 13, 1992 (thickness in cm)

4.0 DISCUSSION

The series of bathymetric surveys conducted at CSDS between August 1991 and May 1992, the current and suspended sediment information from bottom and mid-water moorings, and the REMOTS® survey, all provided circumstantial evidence for active bed transport at the site. The depth-difference comparisons between consecutive bathymetric surveys provided some indication of shifts in sediment accumulation due to both the release of dredged material at different locations as well as transport by bottom currents.

Between the August and October surveys, barges released dredged material around buoy A (Figure 3-4). A depth difference plot of these two surveys showed some accumulation up to 200 m east and south of the disposal buoy (Figure 3-3). This is consistent with the barge disposal pattern. Large areas of accumulation were also seen more than 200 m south of A and north and west of A. Each of these latter areas extended 400 m or more east/west. The source of this accumulation could be the material released by the barges. Background levels of suspended sediments increased during dredged material disposal as the material accumulated on the seafloor and was subjected to tidal resuspension and winnowing. The increased background levels of suspended sediment during September, if they indicated that the material has been resuspended and is then being moved (active bed transport), could explain the accumulation pattern seen in Figure 3-3. Variations in the predominant current flow between BTM-A and BTM-B (Figure 3-10) may be due to variations in local topography (Bohlen et al. 1992). Similar modifications to the bottom current by local topography may cause the slight southwest/northeast trend in the accumulation pattern south of buoy A.

From October to December, only 13,891 m^3 of fine-grained material from the dredging of North Cove was released at CSDS. The depth-difference between the October and December surveys shows no accumulation at the disposal location (Figure 3-6). It does, however, show a loss of material at the southern edge of the survey, and an accumulation running east/west just south of A. The apparent displacement of this material along the east-west axis is again consistent with the dominance of westerly currents.

Despite evidence for active sediment transport at CSDS, material did accumulate at the B disposal location between October and May (Figure 3-9). The accumulation of dredged material at buoy B may be due to the amount and type of dredged material released at CSDS. More than twice as much material was disposed at location B (103,375 m^3) than at location A (50,803 m^3). The dredged materials released at B were fine-grained, cohesive sediments that had been mechanically dredged. Cohesive sediments dredged in this fashion are likely to be deposited at the disposal site as blocks or clumps of material that will reach the seafloor rapidly with little or no dispersion (Bokuniewicz 1989). By contrast, the sandy material dredged from the Connecticut River Bars was hydraulically dredged, which resulted in noncohesive material that was easily resuspended. Suspended sediment measurements,

although they were collected during the first two weeks of disposal at B, were not reported (Bohlen et al. 1992), and possible water column transport of this material could not be determined.

The REMOTS® survey conducted at the completion of the North Cove dredging project substantiated the accumulation of fine-grained dredged material near buoy B (Figure 3-8), and provided additional evidence for active bedload transport of sands near buoy A. As in previous REMOTS® surveys at dredged material disposal mounds (e.g., Germano et al. 1994) the areal extent of dredged material detected by REMOTS® was greater than that detected acoustically. Unlike more quiescent disposal sites, the REMOTS® stations at CSDS detected a layer of sand over the dredged material that, in general, increased in thickness with increasing distance from the mound center (Figure 3-12). The detection of fresh fine-grained dredged material with no sand layer at the buoy location, surrounded by REMOTS® stations where a layer of sand was over the mud, indicated that the sand had moved over the finer grained dredged material after the dredged material was deposited. This process would tend to reduce the rate of dispersion of fine-grained materials deposited at the site.

The sand seen in the REMOTS® photographs, whether dredged material was detected beneath it or not, was either fine-grained with sand ripples or coarser grained with shell fragments. The stations with fine-grained sand were concentrated in the south central or deeper areas of the REMOTS® grid and showed well-developed sand ripples approximately 1.5 to 3.0 cm high. The coarser grained sands with shell fragments and pebbles on the surface were located on the shallower slope in the northern portion of the survey area. The areas covered by shell fragments and pebbles are examples of lag deposits where the fine material has been winnowed away. Once the shell fragments and pebbles are left behind, biota, particularly hydroids, begin to grow in the area (Fenster et al. 1990). The presence of these two sedimentary types is indicative of areas that are accumulating or transporting sediment (where there is sand over mud and/or sand ripples) and areas that have been winnowed or eroded (where there are shell fragments and pebbles).

This visual information, combined with measured current and suspended sediment records, supports the conclusion that CSDS experiences active bedload transport that is apparently dependent on local topography and the nature of materials introduced to the site. Further investigations could clarify whether the accumulation of materials is dependent on the type of dredging (mechanical or hydraulic) or grain size. These results could then be incorporated into future monitoring plans for CSDS.

5.0 CONCLUSIONS

Evidence of active bed transport at CSDS prior to 1991 prompted concern over the possible transport of suspended sediment north of the site and onto nearby oyster beds. The present study, conducted during the disposal of sandy and fine-grained dredged materials, concluded that:

- The predominant transport direction at the site appears to be east-west. This is supported by current meter deployments and observed erosion and deposition patterns.
- Sediment disposed at the site was not immediately dispersed and was defined within discrete deposits. This was observed for both fine-grained and sandy sediments.
- The dispersion process appears to occur over a period of weeks to months. The dispersion rate for fine-grained materials may be markedly slowed by sand armor that migrates over the more cohesive, less erosive silt-clays.

The above findings, taken over the ten-month time period, reduce concerns about far-field transport of material over oyster beds to the north. The dispersion of material over a time scale of years, and the effectiveness of the sand armor over the silt-clays, are unknown.

6.0 REFERENCES

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INDEX

Plate 3-1.

Fresh dredged material at CSDS REMOTS® Station G9, May 12, 1992

Plate 3-2.

Sand over fine-grained dredged material at CSDS REMOTS® Station E7, May 12, 1992

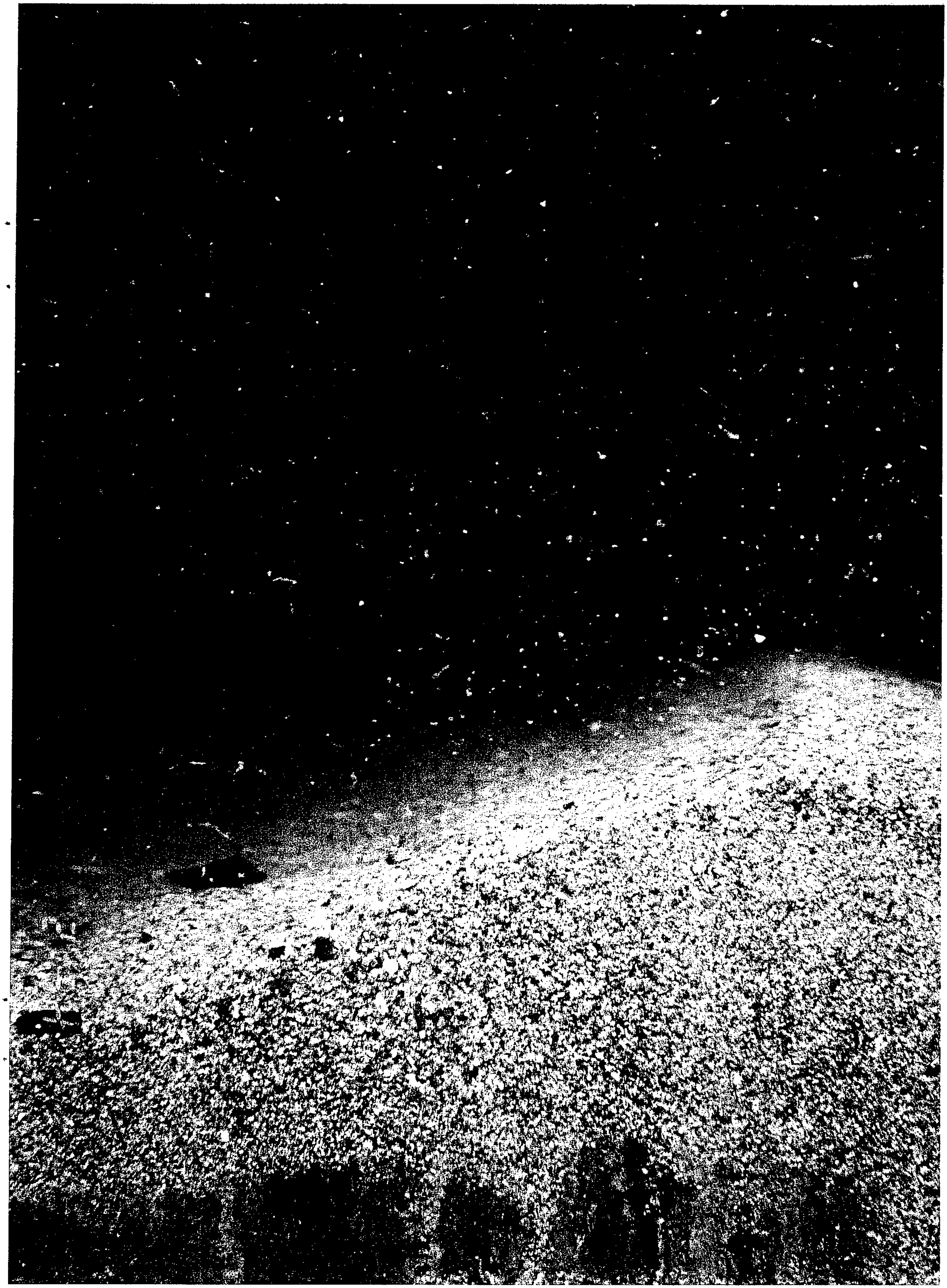

Plate 3-3.

Ambient sand at CSDS REMOTS® Station E13, May 12, 1992

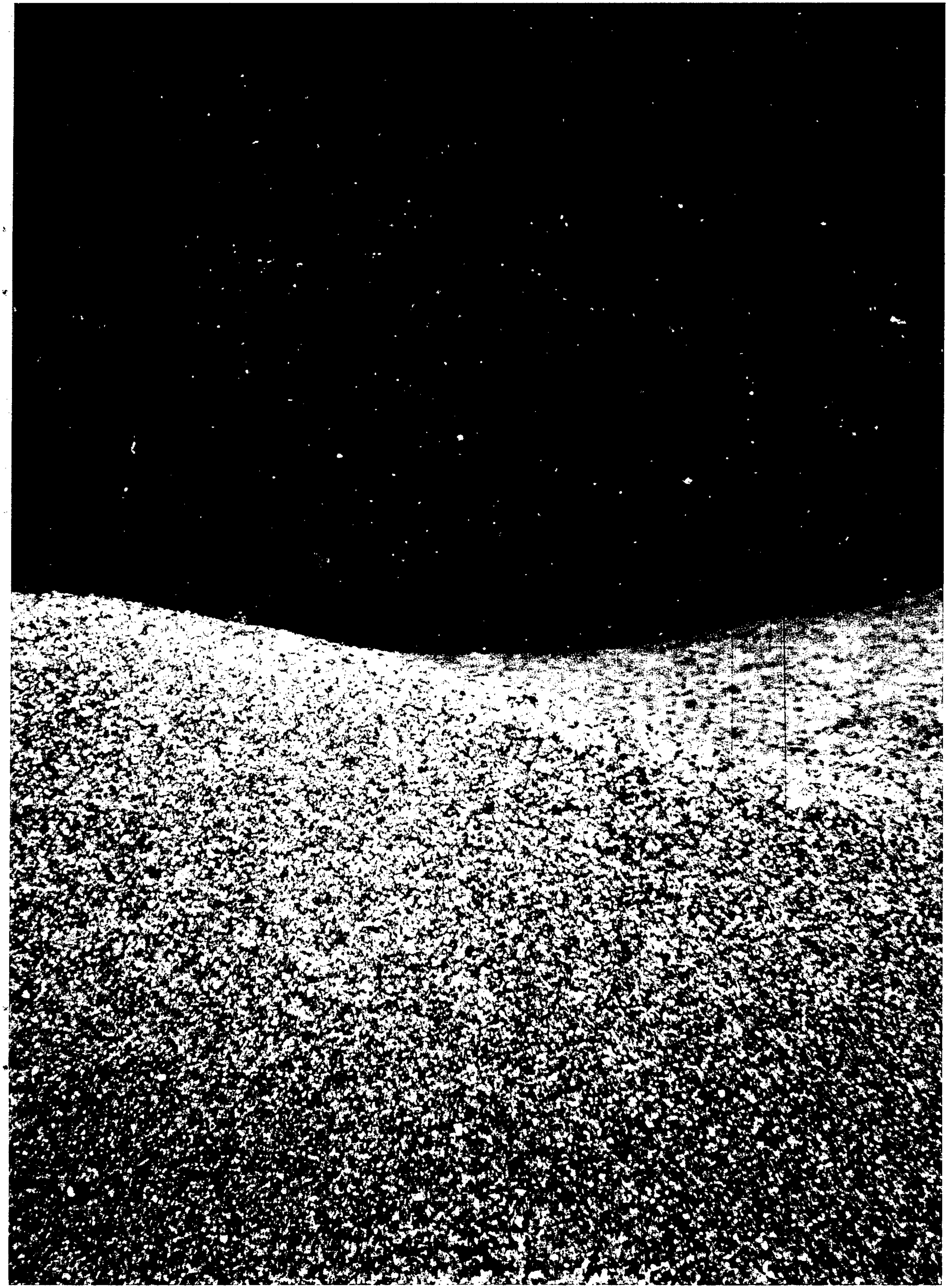

Plate 3-4.

Sand with pebbles, shell fragments and hydroids at CSDS REMOTS® Station I9, May 12, 1992